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SHORT COMMUNICATION

MATING WITHOUT SEXUAL CANNIBALISM IN *TIDARREN SISYPHOIDES* (ARANEAE, THERIDIIDAE)

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ABSTRACT. Copulatory behavior of *Tidarren sisyphoides* is described for the first time. Courtship proceeds without construction of a mating thread. The male dies during insertion and remains coupled to the female epigynum for 2.4 hours on average (n = 15). In contrast to other species hitherto studied, females of *T. sisyphoides* do not consume their mates after copulation. Instead, the dead males are removed from the webs by the females.

Keywords: One-palped spiders, copulatory behavior, male sexual suicide, mating plug

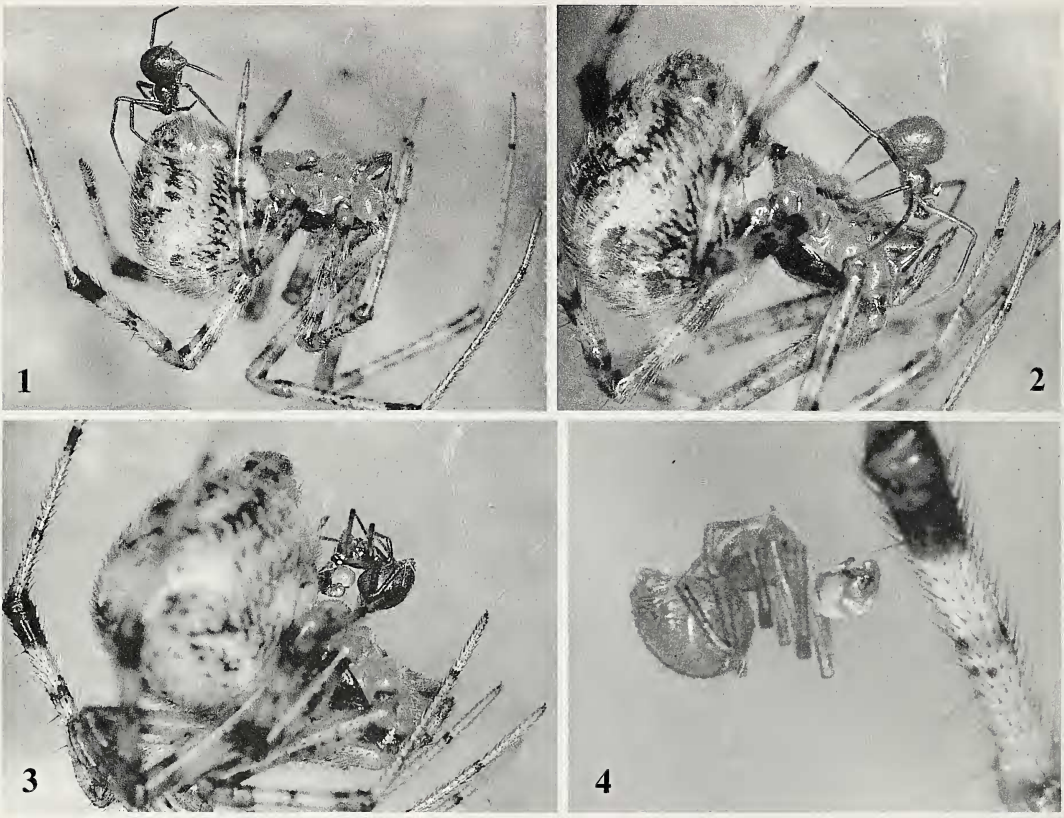
The spider genera with a single male palp, *Tidarren* and *Echinotheridion*, are famous for their peculiar morphology and behavior (Chamberlin & Ivie 1934; Branch 1942; Levi 1955; Schmidt 1980; Knoflach & van Harten 2000, 2001; Knoflach 2002). Males dislodge one of their palps by self-amputation shortly after the penultimate molt. Copulation involves a single palpal insertion and always results in the male's death. Sexual cannibalism occurs either after insertion, as in *Tidarren cuneolatum* (Tullgren 1910), or even during insertion by emasculation, as in *T. argo* Knoflach & van Harten 2001 and *Echinotheridion gibberosum* (Kulczynski 1899), and thus in all species hitherto studied (Knoflach & van Harten 2000, 2001; Knoflach 2002). However, as reported herein, the type species *Tidarren sisyphoides* (Walckenaer 1841), which occurs from southern USA to South America, is different from the above species. Sexual size dimorphism is very pronounced in this species (Figs. 1–5).

Material examined: Descendants of one eggsac, Mexico, Chiapas state, Tapachula, Rosario Itzapa, 6.-12.10.2001, leg. S.P. Benjamin and J.A. Garcia-Ballinas. Males and females were reared to adulthood in captivity in Innsbruck. Fecundity is considerable in this species with several hundred eggs in an eggsac (Guarisco 2000). Depository: Voucher specimens (males and females) are deposited in the American Museum of Natural History, New York; California Academy of Sciences, San Francisco; Muséum d'Histoire naturelle, Genève; Muséum d'Histoire Naturelle, Paris; Naturhistorisches Museum Wien.

Postembryonic development: Males molt 3–4 times (incomplete stages within cocoon not taken into account) and mature c.55 days after hatching from the cocoon; females need 5–6 molts and c.100 days to reach maturity (Gonzalez 1982). The subadult stage of males reared from this Mexican eggsac lasted 11.6 days on average (± 0.54 s.e., range 10–18, n = 18).

Palp-amputation: Branch (1942) gives a detailed description of the palp-amputation of *T. sisyphoides* [sub *T. fordum* (Keyserling 1884)]. A few hours after the penultimate molt, one palp is twisted off and thereafter sucked out by the male spider. One amputation took place 1h 40min after the molt and lasted only three minutes (pers. obs.).

Copulatory behavior: Altogether 15 copulations were observed. When introduced into the females' webs, males almost immediately became active ($\bar{x}$ = 0.9 min, n = 13). Courtship was rather short, 1.6 min on average (± 0.26 s.e., range 0.3–3.7 min, n = 13) and females generally remained completely motionless. In one out of 15 cases the female vibrated her abdomen once. In contrast to other one-palped spiders, courtship proceeded without construction of a mating thread by the male. Distant courtship movements of the male, if performed at all, consisted of some walkabouts near the female, sometimes combined with irregular web-spinning behavior (n = 3) and/or jerks (n = 2). Only one male intensively shook his body. In seven cases, there were no distant courtship movements and direct contact courtship predominated. After contacting the female, the male palpated the female's hind legs or abdomen, mounted the female venter from



Figures 1–4.—Phases of copulatory behavior in *Tidarren sisyphoides*. 1. Male mounting venter of female. 2. Contact courtship: male palpating sternum and mouthparts of female. 3. Copulation: male's legs already contracted. 4. Dead male removed from the epigynum after 'passive' insertion, not consumed by female. Note size of female's tibia IV for comparison.

behind (Fig. 1) and sometimes also moved forward to the female's sternum, throughout palpating her body and her hindlegs with his legs (Fig. 2). In response to these movements, the female lowered her body. This apparently represented the copulatory posture.

To achieve insertion, the male approached the epigynum from behind. Each insertion succeeded at once on the first attempt. The large modified cymbium was put over the epigynal protuberance and was immediately fixed. At the beginning of copulation the male's legs were stretched straight out. After approximately three minutes his legs became contracted, which evidently indicated the male's death (Figs. 3, 5). He remained passively coupled to the female, while she was cataleptic. There were no obvious movements by either partner. Duration of copulation was highly variable, ranging from 14–380 minutes and lasting on average 146 (± 36.7 s.e.; n = 15) minutes. Finally, the female removed the dead male from the epigynum and cast him away without cannibalizing him (n = 15). His palp remained inflated (Fig. 4). Copulatory scars, which were presumably produced from copulation by piercing the posterior epigastric region in *Echinotheridion cartum* Levi 1963 (Ramirez & Gonzalez 1999), have not been found in *T. sisyphoides*.

Multiple mating: Copulations with a second male were similar to first copulations. This is to be expected, as one receptacle still is virgin after the first copulation (see Knoflach & van Harten 2000). Two females were allowed to copulate a third time. In one case, the third male inserted his palp as usual, but was removed by the female after just three minutes. Prior to this insertion the female vibrated her abdomen and moved her legs II up and down. Both movements are reminiscent of typical courtship elements of other *Tidarren* females (Knoflach & van Harten 2000, 2001). No copulation took place with the second female. The male immediately mounted the female's venter, but the female was restless. The male calmed her by climbing forward to her mouthparts and back again, always palpating her. Finally, his mouthparts touched her epigastric furrow and his palp touched her epigynum without being inserted. After three minutes of such contact the fe-

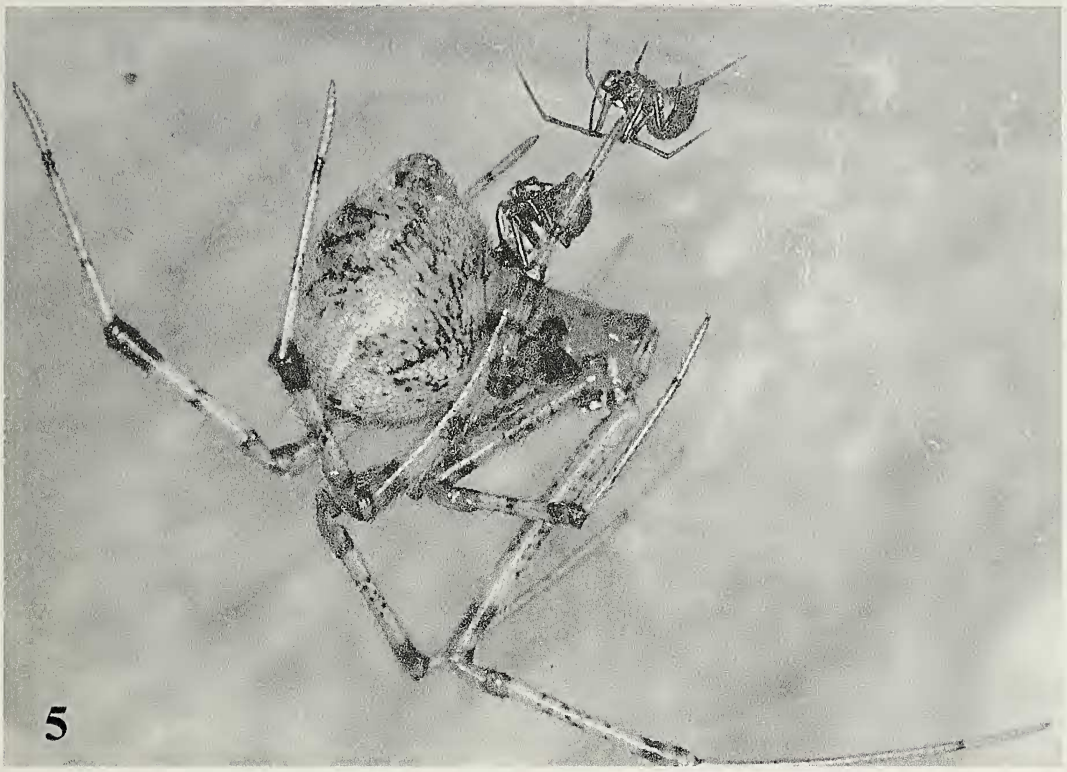


Figure 5.—Copulation in *Tidarren sisyphoides*. Approach of second male, which was the successive mate.

male pulled him off with her hindlegs. The male again approached after one minute, mounted her and repeated contact courtship as described above. Again his mouthparts were positioned on her epigastric furrow, as if he was ingesting fluid. He was again pushed away and then left her web. Although the sample size was small, it should be noted that both females were unusually active, no longer cataleptic.

The sudden death of males appears to coincide with copulation in all one-palped spiders. In *T. sisyphoides* the male's legs become contracted after three minutes. Emasculation, amputation of the male palp by the female, as known for *T. argo* and *E. gibberosum* (Knoflach 2001; Knoflach & van Harten 2000, 2001) and perhaps to be assumed also for *E. cartum* (see Ramirez & Gonzalez 1999), is not present in *T. sisyphoides*. Instead of the separated male palp, the entire male body of *T. sisyphoides* may serve as a temporary mating plug, lasting 2.4 hours on average. The moment of removal is determined by the female. She may pull off the male in as little as 14 minutes or after more than six hours. Interestingly, sexual cannibalism does not take place in *T. sisyphoides*, although females preyed upon insects, which were similar in size than the males. This also confirms that absence of predation on males was not because females were satiated. Copulation of *T. sisyphoides* differs from the other known one-palped spiders by the following: no mating thread is constructed, female courtship is not discernible and sexual cannibalism does not occur. Have all these elements been secondarily lost in this species? As sexual size dimorphism is much larger in *T. sisyphoides* than in the other species, consumption of the dead male may therefore have been reduced in this species. A better understanding of the phylogeny of the species of *Tidarren* and *Echinotheridion* will probably help to elucidate the evolution of these behaviors.

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LITERATURE CITED

Branch, J.H. 1942. A spider which amputates one of its palpi. Bulletin of the Southern California Academy of Science 41:139–140.

Chamberlin, R.V. & W. Ivie. 1934. A new genus of theridiid spiders in which the male develops only one palp. Bulletin of the University of Utah 24: 3–18.

Gonzalez, A. 1982. El desarollo postembrionario de *Tidarren sisyphoides* (Walckenaer) (Araneae, Theridiidae). Physis, Seccion C, Los Continentes y los Organismos Terrestres 41(100):87–91.

Guarisco, H. 2000. Three cobweb spider genera (*Anelosimus*, *Tidarren*, and *Thymoites*) and *Argyrodes fictilium* (Araneae: Theridiidae) recently discovered in Kansas. Journal of the Kansas Entomological Society 73(3):155–163.

Knoflach, B. 2002. Copulation and emasculation in *Echinotheridion gibberosum* (Kulczynski, 1899) (Araneae, Theridiidae). Pp. 139–144. *In* European Arachnology, Proceedings of the 19th European Colloquium of Arachnology, Aarhus 17–22 July 2000 (S. Toft & N. Scharff eds.). Aarhus University Press, Aarhus.

Knoflach, B. & A. van Harten. 2000. Palpal loss, single palp copulation and obligatory mate consumption in *Tidarren cuneolatum* (Tullgren, 1910) (Araneae, Theridiidae). Journal of Natural History 34:1639–1659.

Knoflach, B. & A. van Harten. 2001. *Tidarren argo* sp. nov. (Araneae, Theridiidae) and its exceptional copulatory behaviour: emasculation, male palpal organ as a mating plug and sexual cannibalism. Journal of Zoology, London 254:449–459.

Levi, H. W. 1955. The spider genera *Chrysso* and *Tidarren* in America (Araneae: Theridiidae). Journal of the New York Entomological Society 63:59–81.

Ramirez, M.J. & A. Gonzalez. 1999. New or little-known species of the genus *Echinotheridion* Levi (Araneae, Theridiidae). Bulletin of the British Arachnological Society 11:195–198.

Schmidt, G. 1980. Beobachtung einer Kopulation zwischen Spinnen zweier Gattungen. Verhandlungen 8. Internationaler Arachnologen-Kongreß, Wien 1980:229–232.

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